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Capacitor Behavior in Neutral Electrolytes of Ordered Mesoporous Manganese Oxide Obtained from Oxidation of Perfluorinated Alkenes by Soft Template $CTAMnO_4$

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Abstract

Ordered mesoporous manganese oxides were produced as a by-product of the oxidation of perfluorinated alkenes by soft template $CTAMnO_4$ (CTA= cetyltrimethylammonium). Pores diameter was in the 2.4-6.0 nm range and pore walls were made of birnessite nanocrystallites. Alkene dimensions influenced the oxides morphological and textural properties, including pore ordering. For a particular alkene (1H, 1H, 2H Perfluoro-1-Decene), the surface specific area (SSA) of the manganese oxide was as high as 265 $m^2.g^{-1}$. Mesoporosity, combined with large SSA, guarantee rapid diffusion and access of the electrolyte to the electrochemical capacitor electrode surfaces. Composites of mesoporous oxides, black carbon and Teflon in a 75/12.5/12.5 weight ratio provided capacitances in the 150-175 $F.g^{-1}$ range in neutral aqueous 1M K_2SO_4 electrolyte. Asymmetric AC||MnO_2 devices, cycled reversibly in a 0-1.7 V voltage window, had a pore-depending activation time during which capacitance increases upon cycling. Ragone plot for these MnO_2-based electrodes shows suitable gravimetric energy retention with increasing power, comparable or higher than most of the literature results concerning composite electrodes (except for microsupercapacitors). For instance, energy provided by such devices, at power close to 0.2 $kW.kg^{-1}$, approaches 20 $Wh.kg^{-1}$. From this point of view, our devices can compete with others containing a very high amount of low density and expensive conductive additive in the positive electrode formulation, which penalizes the volume and cost of the final device.

Keyword: electrochemical capacitors, manganese oxide, ordered mesoporous materials, asymmetric devices, Ragone plot.

1. Introduction